CLAIMS

What is claimed is:

1. A method for decoupling a harmonic signal from an input signal wherein the harmonic signal is harmonic relative to a signal other than the input signal, said method comprising:

multiplying an angular position of the other signal by a value representing the harmonic to obtain an angular position multiple;

multiplying the input signal and a sine of said angular position multiple to obtain a first product signal;

multiplying the input signal and a cosine of said angular position multiple to obtain a second product signal;

filtering said first and second product signals to obtain a DC cosine signal and a DC sine signal;

multiplying said DC cosine signal by twice said sine of said angular position multiple to obtain a first correction signal;

multiplying said DC sine signal by twice said cosine of said angular position multiple to obtain a second correction signal; and

subtracting said correction signals from the input signal.

2. The method of claim 1 further comprising integrating the other signal to obtain the angular position.

3. The method of claim 1 wherein said harmonic value is selected from the group consisting of 1, 2, 6, and multiples thereof.

4. The method of claim 1 performed a plurality of times and for more than one harmonic value.

5. A system for decoupling a harmonic signal from an input signal wherein the harmonic signal is an *Nth* harmonic relative to a signal other than the input signal, said system comprising:

a multiplier that multiplies an angular position of the other signal by *N* to obtain an angular position multiple;

a first sine multiplier that multiplies the input signal and a sine of said angular position multiple to obtain a first product signal;

a first cosine multiplier that multiplies the input signal and a cosine of said angular position multiple to obtain a second product signal;

a first filter that filters said first product signal to obtain a first DC signal;

a second filter that filters said second product signal to obtain a second DC signal;

a second sine multiplier that multiplies said first DC signal by twice said sine of said angular position multiple to obtain a first correction signal;

a second cosine multiplier that multiplies said second DC signal by twice said cosine of said angular position multiple to obtain a second correction signal; and

an adder that subtracts said correction signals from the input signal.

6. The system of claim 5 further comprising an integrator that integrates the other signal to obtain said angular position.

7. The system of claim 5 wherein the input signal includes a current from a motor stator and the other signal includes a stator flux angular speed, said system further comprising an integrator that integrates the angular speed to obtain said angular position.

8. A method for decoupling a harmonic signal from a current input to a motor, wherein the harmonic signal is an *Nth* harmonic relative to a flux angular speed of the motor, said method comprising:

integrating the flux angular speed to obtain a flux angular position;

multiplying the angular position by *N* to obtain an angular position multiple;

multiplying the input current and a sine of said angular position multiple to obtain a first product signal;

multiplying the input current and a cosine of said angular position multiple to obtain a second product signal;

filtering said first and second product signals to obtain a DC cosine signal and a DC sine signal;

multiplying said DC cosine signal by twice said sine of said angular position multiple to obtain a first correction signal;

multiplying said DC sine signal by twice said cosine of said angular position multiple to obtain a second correction signal; and

subtracting said correction signals from the input current.

9. The method of claim 8 wherein the input current includes more than one harmonic signal, said method performed for each of the harmonic signals.

10. A control system for controlling an electric motor, said control system comprising:

a pulse-width modulation (PWM) controller that injects a control signal into an input current to the motor;

a proportional-plus-integral (PI) controller driven by the control signal to estimate a flux angular speed of the motor;

an integrator that integrates the estimated flux angular speed to estimate a flux angular position; and

a harmonic decoupling block that:

uses the estimated flux angular position to obtain a plurality of correction signals representing a harmonic signal that is harmonic relative to the estimated flux angular speed; and

subtracts the correction signals from the input current to decouple the harmonic signal from the input current.

11. The control system of claim 10 further comprising a plurality of harmonic decoupling blocks, wherein each said block decouples a corresponding harmonic signal from the input current.

12. The control system of claim 10 wherein said harmonic decoupling block comprises:

a multiplier that multiplies the estimated flux angular position by a constant representing the harmonic of the harmonic signal to obtain an angular position multiple;

a first sine multiplier that multiplies the input current and a sine of said angular position multiple to obtain a first product signal;

a first cosine multiplier that multiplies the input current and a cosine of said angular position multiple to obtain a second product signal;

a first filter that filters said first product signal to obtain a first DC signal;

a second filter that filters said second product signal to obtain a second DC signal;

a second sine multiplier that multiplies said first DC signal by twice said sine of said angular position multiple to obtain a first of said correction signals;

a second cosine multiplier that multiplies said second DC signal by twice said cosine of said angular position multiple to obtain a second of said correction signals; and

an adder that subtracts said correction signals from the input current.

13. The control system of claim 12 wherein said constant comprises one selected from the group consisting of 1, 2, 6, and multiples thereof.

14. A method for controlling an electric motor, said method comprising:

injecting a control signal into an input current to the motor to drive a proportional-plus-integral (PI) controller to estimate a flux angular speed of the motor;

integrating the estimated flux angular speed to estimate a flux angular position;

using the estimated flux angular position to obtain a plurality of correction signals representing a harmonic signal that is harmonic relative to the estimated flux angular speed; and

subtracting the correction signals from the input current to decouple the harmonic signal from the input current.

15. The method of claim 14 further comprising decoupling a plurality of harmonic signals from the input current.

16. The method of claim 14 further comprising:

multiplying the estimated flux angular position by a constant representing the harmonic of the harmonic signal to obtain an angular position multiple;

multiplying the input current and a sine of said angular position multiple to obtain a first product signal;

multiplying the input current and a cosine of said angular position multiple to obtain a second product signal;

filtering said first product signal to obtain a first DC signal and said second product signal to obtain a second DC signal;

multiplying said first DC signal by twice said sine of said angular position multiple to obtain a first of said correction signals; and

multiplying said second DC signal by twice said cosine of said angular position multiple to obtain a second of said correction signals.

17. The method of claim 14 performed using a PWM controller.

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18. A motor apparatus having an electric motor and a controller that injects a control signal into an input current to the motor, said apparatus comprising:

a proportional-plus-integral (PI) controller driven by the control signal to estimate a flux angular speed of the motor;

an integrator that integrates the estimated flux angular speed to estimate a flux angular position; and

a harmonic decoupling block that uses the estimated flux angular position to obtain a plurality of correction signals representing a harmonic signal that is harmonic relative to the estimated flux angular speed, and subtracts the correction signals from the input current to decouple the harmonic signal from the input current.

19. The motor apparatus of claim 18 further comprising a plurality of harmonic decoupling blocks, wherein each said block decouples a corresponding harmonic signal from the input current.

20. The motor apparatus of claim 18 wherein said harmonic decoupling block comprises:

a multiplier that multiplies the estimated flux angular position by a constant representing the harmonic of the harmonic signal to obtain an angular position multiple;

a first sine multiplier that multiplies the input current and a sine of said angular position multiple to obtain a first product signal;

a first cosine multiplier that multiplies the input current and a cosine of said angular position multiple to obtain a second product signal;

a first filter that filters said first product signal to obtain a first DC signal;

a second filter that filters said second product signal to obtain a second DC signal;

a second sine multiplier that multiplies said first DC signal by twice said sine of said angular position multiple to obtain a first of said correction signals;

a second cosine multiplier that multiplies said second DC signal by twice said cosine of said angular position multiple to obtain a second of said correction signals; and

an adder that subtracts said correction signals from the input current.

21. The motor apparatus of claim 20 wherein said constant comprises one selected from the group consisting of 1, 2, 6, and multiples thereof.